



The (Emerging) Reality of *Corynespora cassiicola*: Insights from a literature review

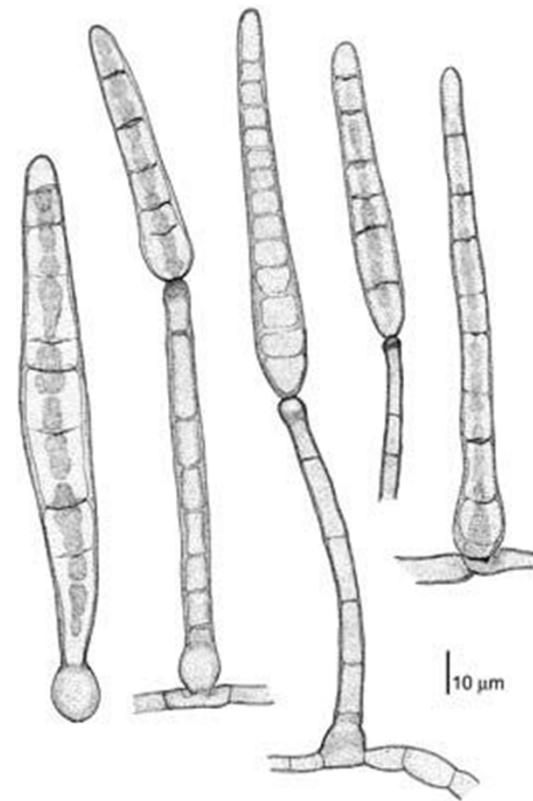
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Major Professor: Dr. Bob Kemmerait

The Course of this Talk

- ❖ Introduction to the Fungal Pathogen
- ❖ The Rise of *Corynespora cassicola*
- ❖ Life Cycle: What's known (or not)
- ❖ Fungicide Resistance

An Introduction ~ Nomenclature ~

- ❖ First described by Berk. & M.A. Curtis **1868** as *Helminthosporium cassicola*
- ❖ *Corynespora cassicola* (Berk. & M.A. Curtis) C.T. Wei 1950
- ❖ **Kingdom:** Fungi
 - Phylum:** Ascomycota
 - Subphylum:** Pezizomycotina
 - Class:** Dothideomycetes
 - Order:** Pleosporales
 - Family:** Corynesporascaceae
- ❖ Common name of disease:
 - **Corynespora leaf spot**
 - **Target spot**



<http://www.mycobank.org/MycoTaxo.aspx?Link=T&Rec=296024>

Pathogen

- ❖ Colony Morphology
 - Grey, Black, Dark brown, Green,
 - Concentric rings
- ❖ Conidiophores
 - Simple, erect, intermittently branching and septate
 - Enteroblastic conidiogenous cells produce subhyaline conidia singly or in chains.
- ❖ Conidia
 - Variable in size and shape
 - 4-17 pseudosepta
 - Range from 40-220 μm in length and to 8-22 μm in width, straight to curved with rounded apex and truncate base
 - Conspicuous thickened hilum

Ellis, M. B., and Holiday, P. 1971. *Corynespora cassicola* (Berk. & Curt.) Wei. Commonwealth Mycological Institute Descriptions of Fungi and Bacteria No. 31, Sheet 303.

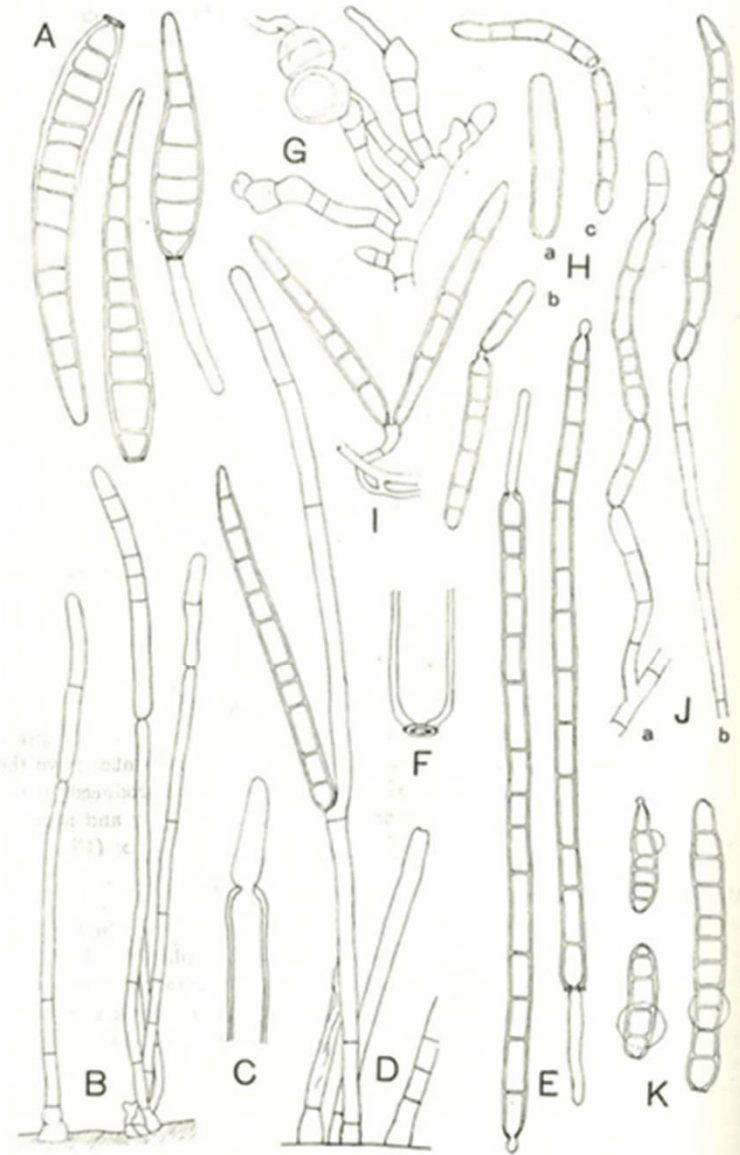


FIG. 3. *Helminthosporium vignae* sp. nov. A-E. Conidiophores and conidia from diseased cowpea leaves. F. Hilum end of conidium. G. Chlamydospores from agar culture. H-K. Conidia and conidiophores from agar culture. All figures $\times 340$, except B, $\times 200$.

Olive L.S., Bain D.C., and Lefebvre C.L. 1945.

A leaf spot of cowpea and soybean caused by an undescribed species of *Helminthosporium*. *Phytopathology* 50, 263-6.

Host Range

❖ *C. cassiicola* has wide host range
- from tropical and subtropical countries

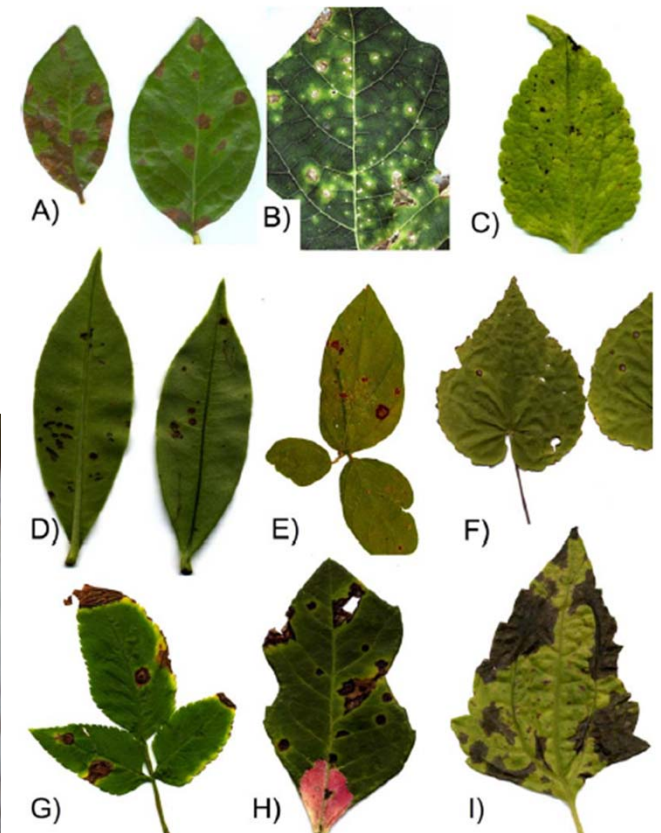
- **530 plant species from 380 genera**, including monocots, dicots, ferns, and one cycad
- Includes saprotrophic and endotrophic isolates

❖ Reported on diverse substrates:

- plant leaves
- stems
- roots
- nematode cysts
- human skin



Huang, H.-K. et al. - Taiwan



Dixon, L. J. 2008. Dissertation. University Of Florida

1. Dixon, L. J., Schlub, R. L., Pernezny, K., and Datnoff, L. E. 2009. Host specialization and phylogenetic diversity of *Corynespora cassiicola*. *Phytopathology* 99:1015-1027.
2. Huang, H.-K., Liu, C.-E., Liou, J.-H., Hsiue, H.-C., Hsiao, C.-H., and Hsueh, P.-R. 2010. Subcutaneous infection caused by *Corynespora cassiicola*, a plant pathogen. *Journal of Infection* 60 (2):188-190.

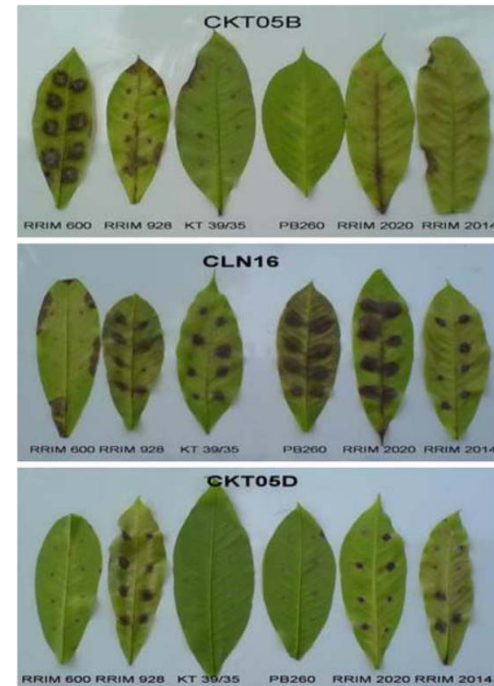
Major Diseases Caused by *Corynespora cassiicola*

❖ Rubber (*Hevea brasiliensis*)

- **Corynespora Leaf Fall Disease**
- First epidemic to gain notoriety
- Sri Lanka - **4600** ha of rubber clone (RRIC 103) **destroyed** since 1987
- Malaysia, Indonesia and Thailand



<http://mvmtechnologies.info/main/index.php?id=164>



Nghia et al., 2008.

1. Silva, W. P. K., Karunanayake, E. H., Wijesundera, R. L. C., and Priyanka, U. M. S. 2003. Genetic variation in *Corynespora cassiicola* : a possible relationship between host origin and virulence. *Mycological Research* 107 (5):567-571.
2. Fernando, T.H.P.S., Jayasinghe, C.K., Wijesundera, R.L.C. and Siriwardana, D. 2010. Screening of fungicides against *Corynespora* leaf fall disease of rubber under nursery conditions. *Journal of Plant Diseases and Protection*, 117 (3), 117–121

Other Epidemics of Note \approx 30 years

❖ Cucumber (*Cucumis sativus*)

- Recently, corynespora leaf spot has become one of the most important diseases of cucumber.
- 7- to 10-day intervals during the 4-5 month growing season



www.invasive.org

❖ Tomato (*Lycopersicon esculentum*)

- Serious pathogen on winter grown tomatoes
- Losses in marketable yield of 11 800 kg/ha



Gary Vallad . UF, Gulf Coast REC

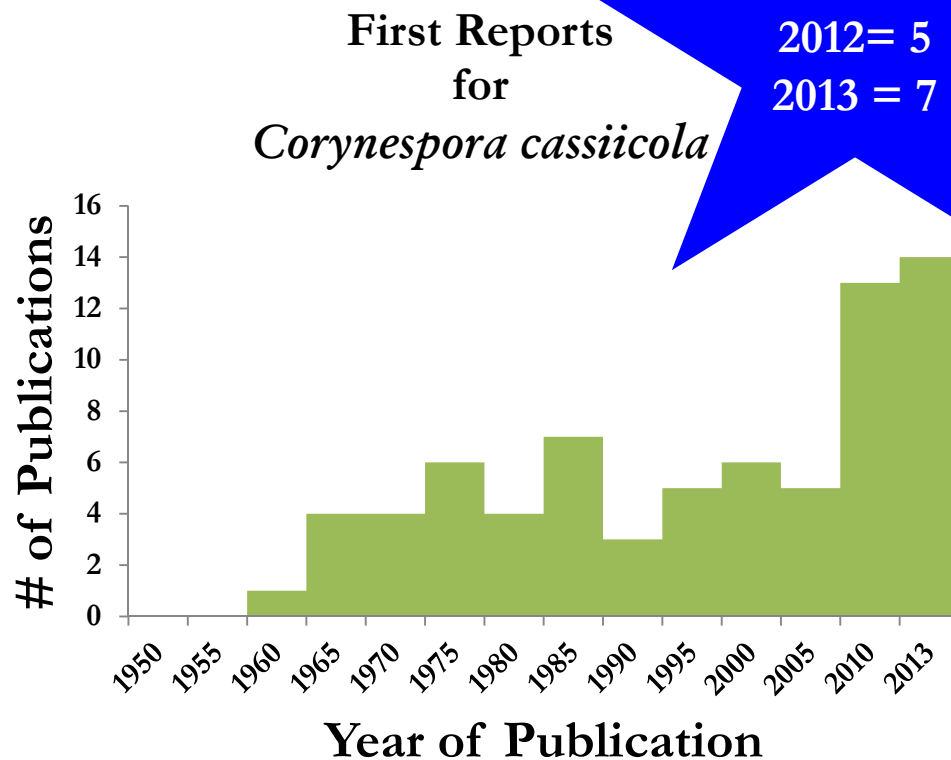
1. Miyamoto, T., Ishii, H., Stammler, G., Koch, A., Ogawara, T., Tomita, Y., Fountaine, J. M., Ushio, S., Seko, T., and Kobori, S. 2010. Distribution and molecular characterization of *Corynespora cassicola* isolates resistant to boscalid. *Plant Pathology* 59 (5):873-881.
2. Pernezny K., Stoffella P., Collins, J., Carroll A., Beaney A. (2003): Control of target spot of tomato with fungicides, systemic acquired resistance activators, and a biocontrol agent. *Plant Protect. Sci.*, **38**: 81-88.



The Rise of *Corynespora cassiicola*

- ❖ Increasing awareness?
- ❖ **Or**
- ❖ Increasing aggressiveness / dissemination of virulent isolates?
- ❖ All of the above?

- ❖ 72 documented first reports from 1957 – 2013
 - Google Scholar, APS Journals, Australasian Plant Disease Notes



1. Miyamoto, T., Ishii, H., Stammler, G., Koch, A., Ogawara, T., Tomita, Y., Fountaine, J. M., Ushio, S., Seko, T., and Kobori, S. 2010. Distribution and molecular characterization of *Corynespora cassiicola* isolates resistant to boscalid. *Plant Pathology* 59 (5):873-881.



Increasing First Reports¹

Documented since 2005



1. Shimomoto, Y., Sato, T., Hojo, H., Morita, Y., Takeuchi, S., Mizumoto, H., Kiba, A., and Hikichi, Y. 2011. Pathogenic and genetic variation among isolates of *Corynespora cassiicola* in Japan. *Plant Pathology* 60 (2):253-260.
2. <http://apsjournals.apsnet.org>
3. <http://www.publish.csiro.au/index.cfm>

2011 - Proof of Target Spot

Koch's Postulates

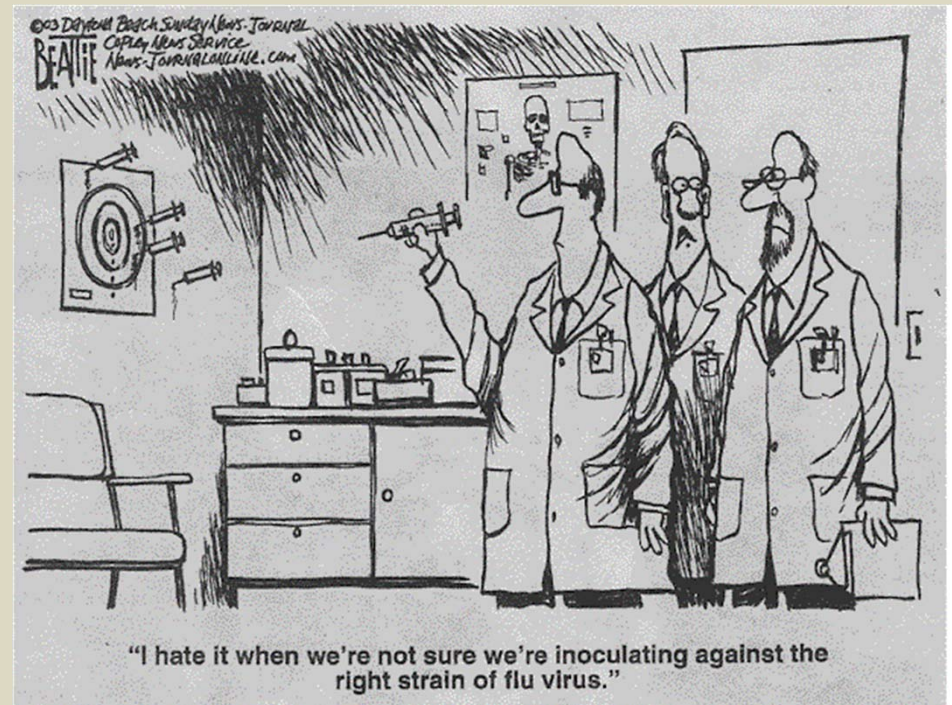
- ❖ 100% of inoculated plants showed symptoms
- ❖ No symptoms found on non-inoculated plants
- ❖ Fungus was re-isolated, cultured, and confirmed by morphological characteristics and PCR
- ❖ Symptoms associated with this disease



Life Cycle of *Corynespora cassicola*

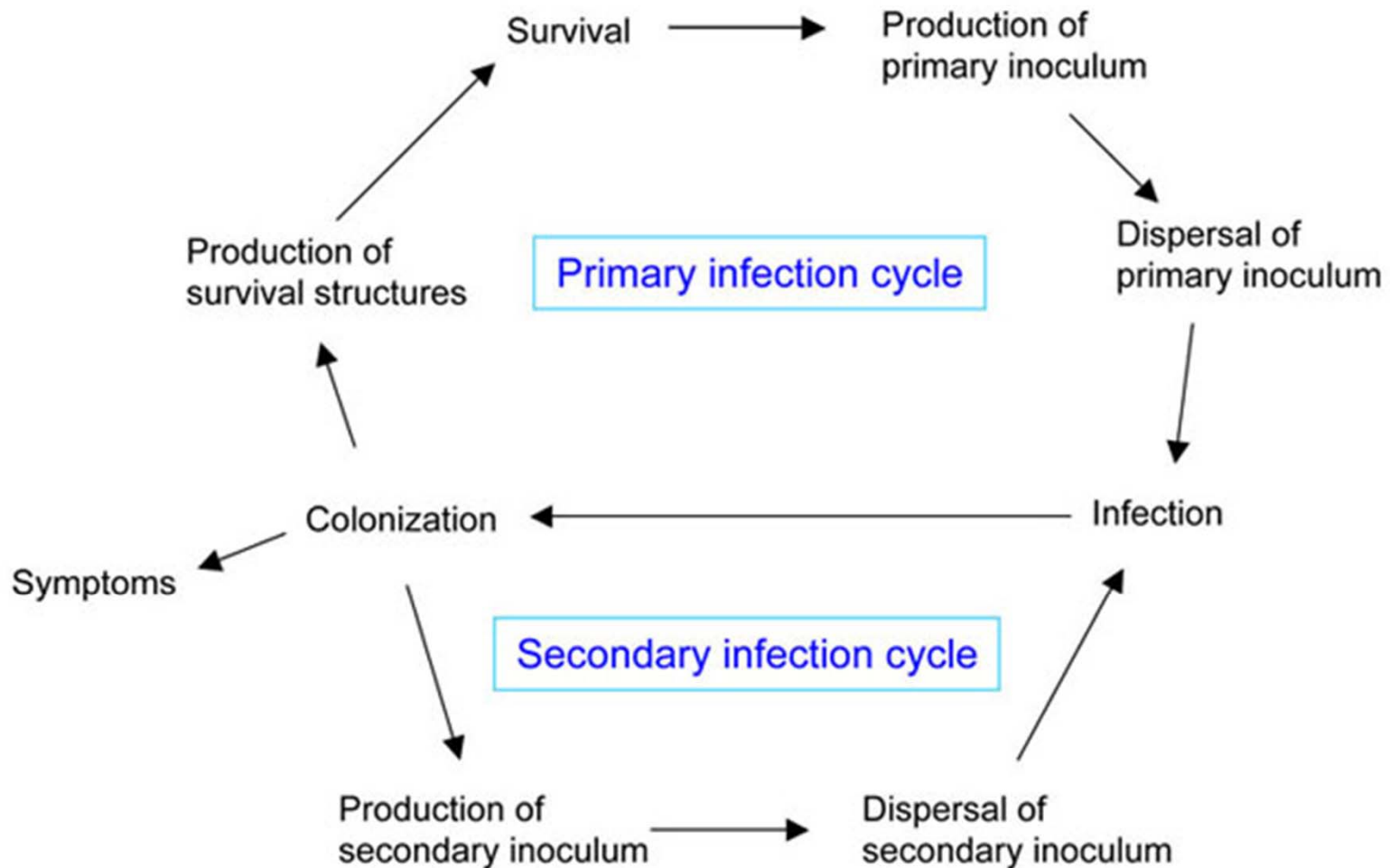
The Evolution of An Educated Guess

THE **BLANKSHEET** PROJECT



A Typical Life Cycle Scenario

Prediction: Anticipating the Behavior



Development of Disease?

Factors involved in Predicting Disease Severity

- ❖ How does it overwinter? How long can it survive?
 - ❖ What's the effect of tillage and crop rotation?
- ❖ When does the pathogen emerge/start sporulating?
 - ❖ Secondary inoculum?
- ❖ What is the relationship between environment and infection, etc?
- ❖ When does infection begin?
 - ❖ Based on phenology, weather, planting date, etc?
 - ❖ All of the above?

Epidemiology

Optimum Environment

Host	Temperature	Leaf Wetness
Tomato	20-28°C (68-82.4)	> 16 hours necessary
Cucumber	25-30°C (77-86°F)	-
Tobacco	27.5-30°C (81.5-86°F)	-
Rubber	25-30°C (77-86°F)	Greatest at 90%
Cotton	?	?

Mild Temperatures
Prolonged Leaf Wetness
- But to what extent?



A Hopeful Demise?

Suppression with Fungicides

❖ Fungicide Dependence

- Cucumbers
- Tomatoes
- Papaya
- Rubber –

❖ Resistance is a major concern

- Strobilurins (QoI)
- Boscalid (SDHI)



Rubber Institute of Sri Lanka



• **Endura**
fungicide





Cucumber Fungicide Trial

Japan



❖ Corynespora leaf spot

- Now 3rd most important disease in cucumber
- Increasing severity in greenhouse production

❖ Fungicide resistance

- Already high frequency of resistance to:
 - Benzimidazoles
 - Strobilurin (QoI) ~ 6 years
 - Miyamoto et al. (2009) – DNA analysis suggests that resistant isolates were present before the introduction of QoI fungicides
- Boscalid - succinate dehydrogenase inhibitor (SDHI)
 - Japan: Registered in 2006 (very effective control)
 - Wide spread Resistance reported in 2009

Miyamoto, T., Ishii, H., Seko, T., Kobori, S., and Tomita, Y. 2009. Occurrence of *Corynespora cassiicola* isolates resistant to boscalid on cucumber in Ibaraki Prefecture, Japan. Plant Pathology 58 (6):1144-1151.



Target Spot of Tomato

Florida

❖ Target Spot

- Most serious disease of winter grown crop
- Historically controlled with Bravo

❖ Fungicide resistance

- QoI – First documented in 2001



Gary Vallad . UF, Gulf Coast REC

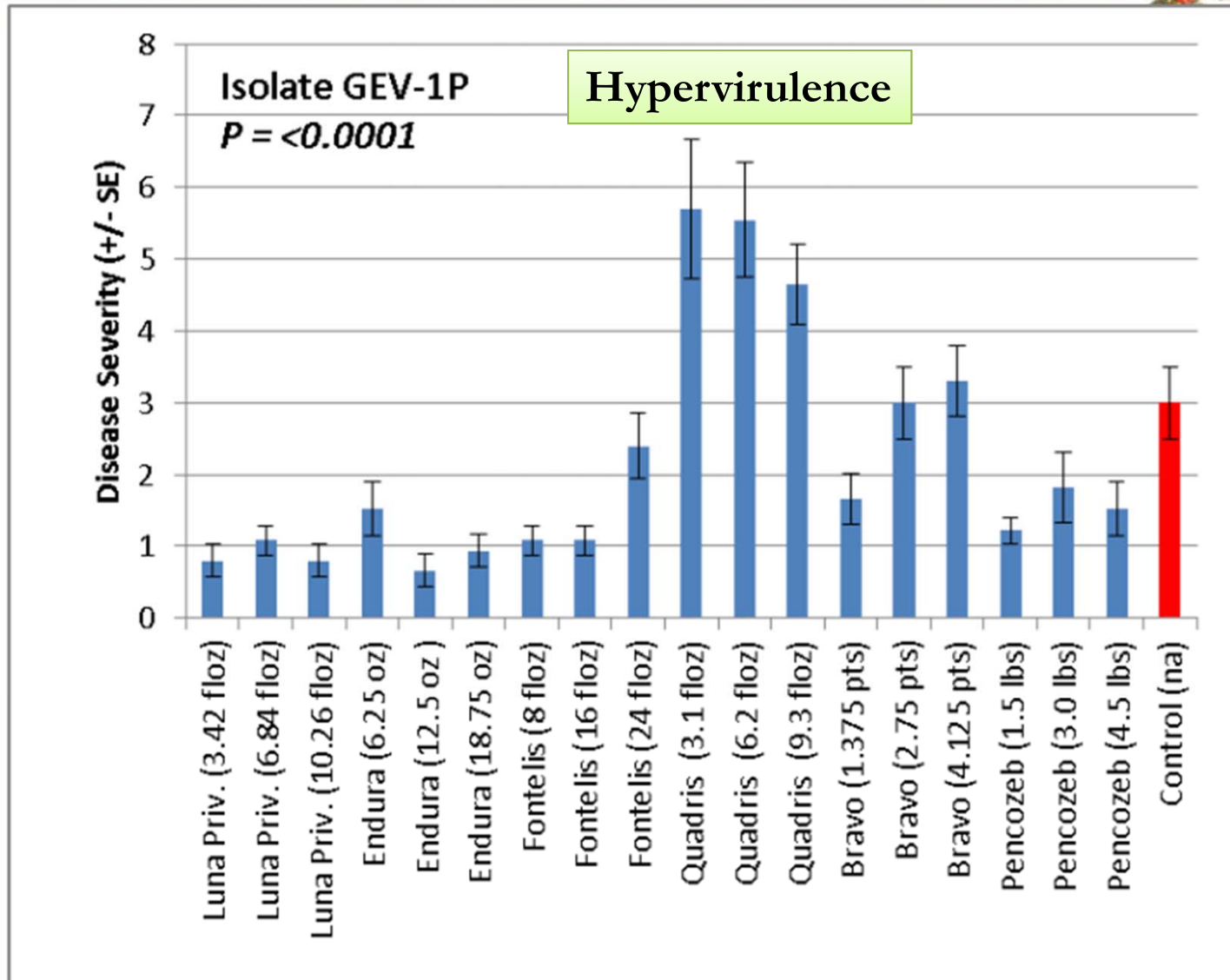
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Sensitivity of *Corynespora cassicola* isolates to fungicides based on plug-method

Isolate	Estimated EC ₅₀ :			
	Boscalid	Penthiopyrad	Azoxystrobin	Pyraclostrobin
GEV-2P	1.62	1.03	> 50	> 50
GEV-3G	1.78	1.21	> 50	14.8
GEV-4P	1.06	1.47	> 50	> 50
GEV-5G	1.51	1.03	> 50	7.9
GEV-6P	1.51	1.16	> 50	> 50
GEV-7P	> 50	5.23	> 50	> 50
GEV-8G	> 50	> 50	> 50	> 50
GEV-102008	1.01	0.59	> 50	13.3
GEV-1P	4.43*	1.00	> 50	> 50
GEV-081208	3.53*	1.01	> 50	> 50
GEV-111408	3.46*	1.00	> 50	> 50



Fungicides Labeled in Cotton

❖ Currently – strobilurin chemistries are primary MOA labeled for cotton:

- **Headline**
- **Quadris**
- **Twinline**
 - Metconazole

All Strobilurins



Photo: Courtesy Dr. Bob Kemeraite & J. Brock

Headline
fungicide

TWINLINE



The Path Ahead



Target Spot of Cotton

- ❖ Emergence
 - Awareness or Aggressiveness
- ❖ Epidemiology
 - Knowledge gap
 - Inability to accurately predict development
 - How can we better predict the behavior of target spot based on the life cycle?
- ❖ Fungicide Resistance
 - High Risk pathogen
 - 3-6 years of use for QoI and SDHI

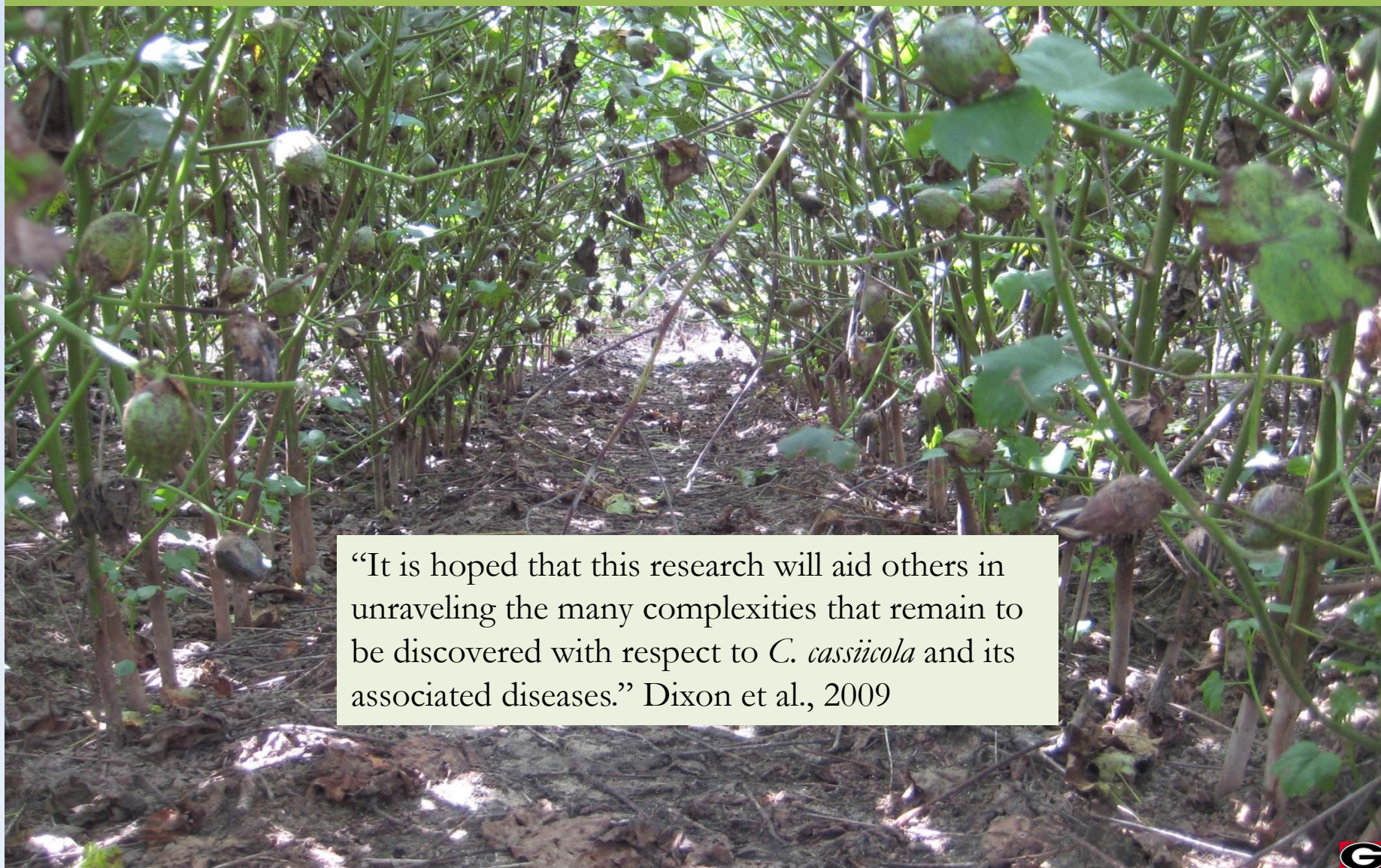


Or



Questions?

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“It is hoped that this research will aid others in unraveling the many complexities that remain to be discovered with respect to *C. cassiicola* and its associated diseases.” Dixon et al., 2009

